UNCLASSIFIED
Security Classification This Page

#1 DNI

REPORT DOCUMENTATION PAGE

1. Report Security Classification: UNCLASSIFIED	
2. Security Classification Authority: N/A	
3. Declassification/Downgrading Schedule: N/A	
4. Distribution/Availability of Report: DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.	
5. Name of Performing Organization: Dean of Academics Office	
6. Office Symbol: 1	**7. Address:** NAVAL WAR COLLEGE 686 CUSHING ROAD NEWPORT, RI 02841-1207
8. Title (Include Security Classification): "Approaches to Enhance Sensemaking for Intelligence Analysis"	
9. Personal Authors: Michael S. McBeth	
10.Type of Report: FINAL	**11. Date of Report:** 17 May 2002
12.Page Count: 24	
13.Supplementary Notation: A paper submitted to the Dean of Academics, Naval War College, for the Director of Naval Intelligence (DNI) Award essay competition. The contents of this paper reflect my own personal views and are not necessarily endorsed by the NWC or the Department of the Navy.	
14. Ten key words that relate to your paper: Sensemaking, Intelligence Analysis, Psychology, R.V. Jones, Problem Solving, Language, Reasoning, Analogy, Stories, Persuasion	

15.Abstract: This essay describes four approaches to enhance sensemaking for intelligence analysis. Sensemaking refers to how individuals, groups, and organizations make sense out of their situation and environment. The four approaches are to attack every problem as a Fermi problem, to build a strong vocabulary—with both English and foreign words, to cultivate a knack for reasoning through analogy and stories, and to apply persuasion skills to interact more productively with others. Each approach is explained from a sensemaking perspective and linked to Richard Heuer's *Psychology of Intelligence Analysis*. Examples from the World War II exploits of Reginald V. Jones, the father of modern scientific and technical intelligence, are used to illustrate each approach. Additional examples collected during interviews with six practicing intelligence analysts are also presented. Ideas for how analysts can gain competence in using each approach are suggested. Finally, some ideas for future research are recommended.

16.Distribution / Availability of Abstract: A	**Unclassified**	**Same As Rpt**
	X	X

20021016 168

17.Abstract Security Classification: UNCLASSIFIED	
18.Name of Responsible Individual: Dean of Academics, Naval War College	
19.Telephone: 841-2245	**20.Office Symbol:** 1

Security Classification of This Page: UNCLASSIFIED

NAVAL WAR COLLEGE
Newport, RI

APPROACHES TO ENHANCE SENSEMAKING FOR INTELLIGENCE ANALYSIS

by

Michael S. McBeth
GS-14 Electronics Engineer
Space and Naval Warfare Systems Center, Charleston

A paper submitted to the Dean of Academics, Naval War College, for the **Director of Naval Intelligence (DNI) Award** essay competition.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy

17 May 2002

Michael S. McBeth

Michael S. McBeth

Executive Summary

This report describes four approaches to enhance sensemaking for intelligence analysis. Sensemaking refers to how individuals, groups, and organizations make sense out of their situation and environment. Much of the previous work in sensemaking comes from the fields of business management and organizational psychology. Recently, researchers have begun to apply these ideas to the study of military command and control. In October 2001, the Command and Control Research Program (CCRP) of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence ASD(C3I) sponsored a symposium on sensemaking that identified intelligence analysis as one of four application areas for sensemaking research. It is in this vein the research reported here was undertaken. The four approaches are:

- Attack every problem as a Fermi problem
- Build a strong vocabulary—with both English and foreign words
- Cultivate a knack for reasoning through analogy and stories
- Apply persuasion skills to interact more productively with others

The emphasis is on practical ways intelligence analysts can improve their sensemaking. Each approach is explained from a sensemaking perspective. Examples from the World War II exploits of Reginald V. Jones, the father of modern scientific and technical intelligence, are used to illustrate each approach. When applicable, additional examples collected during interviews with six practicing intelligence analysts are also presented. Next, some ideas for how analysts can gain competence using each approach are suggested. The report ends by suggesting some directions for future research.

Introduction

Intelligence analysts are always performing a balancing act. On the one hand, good intelligence analysis is personalized. Each analyst develops his or her own style. The very nature of the subjects they tackle call for different sources, methods, and analytical techniques to tease intelligence from a sea of conflicting information and uncertainty. On the other hand, analysts belong to a larger intelligence community. They must work as part of a collective. Limited resources and functional boundaries ("lanes in the road") require analysts to collaborate with people in other agencies and organizations. They work in small teams. They work on several projects at the same time. A pull towards specialization is offset by a push towards collaboration.

Yet analysts are able to make sense out of their complex environments. And how they make sense shapes the judgments they reach. So if analysts are able to make better sense of the information at hand their judgments should improve as well. The study of sensemaking may offer some insights into where to look for improvements.

Sensemaking refers to how individuals, groups, and organizations make sense out the situations and environments they confront. Much of the previous work in sensemaking comes from the fields of business management and organizational psychology. Recently, researchers have begun to apply these ideas to the study of military command and control. In October 2001, the Command and Control Research Program (CCRP) of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence ASD(C3I) sponsored a symposium on sensemaking that identified intelligence analysis as one of four application areas for sensemaking research.[1]

Report Organization

This report begins with a brief overview of sensemaking. This includes some thoughts on how sensemaking applies to intelligence analysis and how sensemaking connects with related ideas from the literature on intelligence analysis. Next, the approach used to identify sensemaking enhancements is outlined. Each enhancement is explained from a sensemaking perspective. Examples from the World War II exploits of Reginald V. Jones, the father of modern scientific and technical intelligence, are used to illustrate each approach. When applicable, additional examples collected during interviews with six practicing intelligence analysts are also presented. Next, some ideas for how analysts can gain competence using each approach are suggested. The report concludes by suggesting some directions for future research.

What is Sensemaking?

Karl Weick lists seven basic properties of sensemaking.[2] These properties provide a starting point for understanding the dimensions of sensemaking at the individual, group, and organizational levels. They also have a direct relationship to many of the points that Heuer brings out in his book on the psychology of intelligence analysis.[3] In the descriptions that follow, each sensemaking property is described from an intelligence analyst's perspective and connections with Heuer's work are highlighted. Sensemaking is:

Grounded in identity construction. How we view ourselves determines how we view our environment. Analysts have several roles and a self-image associated with each role. For example, they are spouses, parents, and degreed professionals all at the same time. How they define success and failure also affects how they make sense out of a given situation. Heuer makes the following point: "intelligence analysts must understand themselves before they can understand others."[4]

Retrospective. How we make sense in the present is determined by our previous perceptions. We are always looking backward to establish cause and effect and derive meaning from context. Heuer makes three points that are essentially examples of

retrospective sensemaking. First, "we tend to perceive what we expect to perceive," he said. These expectations are tied to schema that we have learned in the past and our sensory systems are more primed to easily detect. Second, "mind-sets tend to be quick to form but resistant to change." This point is illustrated by a series of images that morph from a man into a woman. What you see as you progress through these images is strongly determined by whether you start on the end with the image of the man or the woman. Third, "new information is assimilated to existing images." Heuer offers this as a reason why an analyst taking a fresh look at an area can generate insights missed by analysts who have studied the same problem for years, but have become insensitive to evolutionary changes.[5]

Enactive of sensible environments. Our actions help determine how we make sense of our environment. Weick maintains that "people [often] create their own environments and these environments often constrain their actions." [6] One example he cites involves an air traffic controller who puts several aircraft into a holding pattern where several near misses occur. For an intelligence related example, consider what happens when an intelligence analyst tasks a collection asset to cover one area while missing important events in another.

Ongoing. Making sense takes place through perceptions carved out of a continuous stream of consciousness. We are always in the middle of a project. Interruptions determine how we "chop moments out of continuous flows and extract cues from those moments." Sensemaking neither "starts fresh or ends cleanly." [7]

Social. Making sense takes place in a social context. It involves shared meaning and shared experience. When individuals make sense they are "influenced by the actual, imagined, or implied presence of others." [8] Intelligence analysts interact with team members, supervisors, and customers. They strive to make sense and communicate meaning within this social network. Heuer points to the need for insights into social sensemaking when he writes, "Problems are not limited to how analysts perceive and process information. Intelligence analysts often work in small groups and always within the context of a large, bureaucratic organization. Problems are inherent in the process that occur all three levels—individual, small group, and organization." [9]

Focused on and by extracted cues. How we make sense involves noticing and extracting cues from our environment. Context and mental state affect how efficiently people pick up and use cues. Familiarity and experience allow people to notice when something unusual occurs or when something important is missing. Fatigue, stress, or overload can make it more difficult to notice cues that would otherwise easily be picked up. Heuer approaches this aspect of sensemaking by noting that "analytical strategies are important because they influence the data one attends to." [10]

Driven by plausibility rather than accuracy. How we make sense involves fitting our perceptions within a context and deriving meaning. Many times if we can come up with something plausible, that is good enough and we move on. Other times we trade speed for accuracy using plausibility as a guide. [11]

How the Approaches to Enhance Sensemaking were Identified

The methodology followed in this research effort started with learning as much as possible about sensemaking through selected readings. These readings were followed by a search for historical examples of sensemaking in intelligence analysis from the work of Reginald V. Jones, a pioneer of British scientific intelligence in World War II. His exploits which include unraveling many Nazi wartime innovations including radio beam guidance systems for bombers, radar, nightfighter defenses, V-1, and V-2 rocket programs. Jones's book, *The Wizard War*, was used as the source for examples.[12] In addition, interviews were conducted with six practicing intelligence analysts. Cognitive probes were used during the interviews to elicit examples of sensemaking.[13]

The approaches to enhance sensemaking were identified by thinking about the processes of sensemaking and intelligence analysis. The examples cited and the intelligence analysts interviewed for this project are all from the Scientific and Technical Intelligence (S&TI) field. However, the approaches to enhance sensemaking are explained in a way that is intended to be useful for other areas of intelligence analysis.

Four Approaches to Enhance Sensemaking in Intelligence Analysis

The four approaches are:

- Attack every problem as a Fermi problem
- Build a strong vocabulary—with both English and foreign words
- Cultivate a knack for reasoning through analogy and stories
- Apply persuasion skills to interact more productively with others

The emphasis is on identifying practical ways intelligence analysts can improve their sensemaking. The approaches can be thought of as competencies that individual analysts can

develop. Many senior analysts undoubtedly follow these approaches as a matter of course. The potential value of their exposition here lies in isolating them from other activities, establishing a link between their sensemaking role and their use in intelligence analysis, and suggesting some ideas for how analysts can gain competence using each approach.

Attack Every Problem as a Fermi Problem

Hans Christian Von Baeyer, a physicist and science writer, describes a method of attacking problems that the Nobel Laureate Enrico Fermi championed and taught to his students.[14] It involves taking a difficult problem for which the answer is unclear and breaking it into a series of smaller subproblems that can be solved using approximations based on assumptions and common knowledge.

Von Baeyer relates a story of how Fermi estimated the explosive yield of the first atomic bomb test simply by tossing a handful of shredded paper bits into the air and measuring the distance they were carried by the blast's shock wave. After a series of quick mental calculations, Fermi proclaimed the yield to be equivalent to about 10 kilotons of TNT. It would take several weeks to process the instrument data that eventually confirmed Fermi's rough estimate.[15]

This method of problem solving is not limited to esoteric scientific domains and Nobel Laureates. Estimating the number of piano tuners in the city of Chicago, an example Fermi used in teaching his physics students, illustrates the larger applicability of the method. There is no standard answer for the piano tuner problem. However, one can find an approximate answer by starting with a series of assumptions and linking them together. Here is a solution that Von Baeyer gives:

> If the population of metropolitan Chicago is three million, an average family consists of four people, and one third of all families own pianos,

> there are two hundred and fifty thousand pianos in the city. If every piano is tuned once every five years, fifty thousand pianos must be tuned each year. If a tuner can service four pianos a day, two hundred and fifty days a year, there must be about fifty piano tuners in the city. The answer is not exact; it could be as low as twenty-five and as high as a hundred. But, as the yellow pages of the telephone directory attest, it is definitely in the ballpark. [16]

Solving problems using this method requires some creativity and self-confidence on the part of the individual. There is no cookbook recipe to follow. However, there are several characteristics that Fermi problems share in common: [17]

- No standard solution exists
- No initial idea for what the answer might be
- The answer cannot be verified by logical deduction alone
- Finding an answer requires a knowledge of facts not mentioned in the problem statement
- Solutions are always approximate
- The problem can be broken down into subproblems where assumptions lead to approximate answers

Developing competence in attacking problems as Fermi did can enhance sensemaking in at least two ways. First, it allows you to quickly get a feel for the order of magnitude you might expect to find answers by more rigorous methods. Second, it provides ideas on where to focus your attention to look for additional clues and information.

Fermi problems can be seen from the perspective of several of the sensemaking properties. Using this method is grounded in identity construction. Von Baeyer points out that an individual's attitude determines how they approach problems and therefore make sense:

> Whether the problem concerns cooking, automobile repair, or personal relationships, there are two basic types of responses: the fainthearted turn to authority—to reference books, bosses, expert consultants, physicians, ministers—while the independent of mind delve into that private store of common sense and limited factual knowledge that everyone carries, make

reasonable assumptions, and derive their own, admittedly approximate, solutions.[18]

Fermi problems can be enactive of sensible environments. In Fermi's case not only did he help create the atomic bomb that was being tested in the desert, he also tossed the paper shreds into the air as a way to make sense out of the magnitude of the blast.

In subdividing a problem and piecing together a solution to a Fermi problem, you must identify, obtain, and manipulate key pieces of information that act as cues. In this way sensemaking in a Fermi problem is focused on and by these extracted cues.

Because the answer to a Fermi problem is always approximate and based on assumptions, it is easy to view this as a form of sensemaking that is driven by plausibility rather than accuracy.

I found seven examples where R.V. Jones engaged in this type of sensemaking. Jones was a Ph.D. physicist whose contributions in helping to defeat the Germans were lauded by Sir Winston Churchill, Prime Minister of Great Britain. Although it is not surprising that a scientist as brilliant as Jones would use Fermi problem solving techniques, his examples show how useful the method can be in intelligence analysis.

Two examples are explored here and a table listing all seven is provided for further study by interested readers. In the first example, Jones is able to estimate the range of two different types of German radars, called Freyas and Würzburgs, based on a few clues, some assumptions, a knowledge of geography and map reading, and some elementary physics:

> … we heard through Enigma [decoded German communications] that a Freya equipment was being sent to Rumania along with another equipment called 'Würzburg' for coastal protection, and that two Würzburgs were being sent to Bulgaria for a similar purpose. Since radar equipment was not very plentiful, I assumed that these were the minimum number of equipments that would just cover the Black Sea coastlines of the two countries, 260 kilometres for Rumania and 150 kilometres for Bulgaria. Each Würzburg in Bulgaria would therefore have to cover 75 kilometres

of front, which it could just do if it had an all-around range of 37.5 kilometres. If this were so, the Freya in Rumania would have to cover (260-75) kilometres, which meant that a Freya must have an all around range of 92.5 kilometres.

> We already knew from Garrard's observations that Freyas sent out 1000 pulses per second, so that their designer was expecting to get the reflected pulses back within a thousandth of a second; and since radio waves travel with the speed of light, roughly 300,000 kilometres per second, the double journey to the target and back could not be longer than 300 kilometres, giving a range of 150 kilometres as a maximum. So the 92.5 kilometres deduced from the slender Rumanian evidence as a minimum was of the right order. [19]

This example contains all the characteristics of a Fermi problem. No standard solution exists. The answer was approximate. The solution called for facts not contained in the intercepted communications traffic or pulse repetition measurements, (essentially the problem statement), that Jones had to work with.

This second example involves estimating the intended rate of fire for the German V-2 rockets in 1944. Jones's explanation speaks for itself:

> One of the ways in which I estimated the intended rate of fire provides an example of the irony of security. When we captured a map in Normandy it showed the storage sites for rockets west of the Seine, and these had a capacity for holding 100-200 rockets. Also shown on the Normandy map were some other sites numbered 15 to 20 inclusive, the numbers running from east to west. These were sites that we had already photographed from the air, and which we had diagnosed as dummies erected to throw us off the scent of some unknown genuine sites. The map gave evidence that these were somehow connected with the rocket, and we could therefore conclude that there were 14 sites to the east of the Seine, some of which we had already photographed and identified of being of the same pattern. Assuming that all these sites were part of a deception programme, and that there was—with German consistency—a fairly rigid relation between the number of dummy sites and the number of genuine ones (none of which we had discovered), I assumed that since there were 14 dummies east of the Seine for six west then the rocket storage capacity east of the Seine would be in the same ratio. So to the 100-200 rockets stored west of the Seine there should be another 100-200 multiplied by 7/3 east of the Seine, giving some 400 rockets stored altogether. Further, assuming that the policy was to hold two weeks' supplies in the stores, as we had found to be the practice with the flying bomb, this would suggest that the Germans intended a rate of firing of about 800 rockets a month. The result of this

admittedly tenuous argument, which was supported by others of a similar nature, was thus surprisingly close to the German intention of 900 a month. [20]

This following table lists seven Fermi problem solving examples from Jones's book.

Example of Jones using Fermi Problem Solving Technique	***The Wizard War* Page Number**
Estimate of German Würzburg and Freya Radar Ranges	192-193
Possibility of making a rocket with a 130 mile range	357
Prediction of the first use of V-1 rocket	417
Estimate of intended rate of fire for V-2 rocket	453
Estimate in the reduction of casualties due to V-1 rocket deception	423
Estimate of the total number of Freyas based on a few serial numbers	199-200
Estimate of the position of radar stations in the Kammhuber line	272

I found a couple of examples of Fermi problem solving techniques having been used by the practicing intelligence analysts I interviewed. One analyst told me that he used "order-of-magnitude estimates to get a feel for the numbers." This type of approximate calculation is exactly what using Fermi problem solving techniques for sensemaking is about. Another analyst told me a story about how the "SAM weave" maneuver, used by combat fighter pilots to evade Surface-to-Air Missiles (SAM), was developed by piecing together separate missile flight dynamic models that were essentially structured as Fermi problems. This could be an example of organizational sensemaking where the pilots received a new way to "make sense" and avoid a threat based on shared knowledge from an intelligence analyst.

A Fermi problem solving approach provides a way to make sense of poorly defined problems—just the sort of problems—faced by intelligence analysts. How does one become adept at using this approach? It starts with attitude and self-confidence. Knowing that you can independently come up with your own approximate solutions to problems. Self-confidence needs to be reinforced by practicing the method and accumulating a few success

stories. One can also learn by studying examples like those of Fermi. Learning to calculate quickly and work with numbers in your head is also a useful skill to acquire. Most people are too dependent on calculators. There may be times when a calculator is not available and often using one is unnecessary when approximating. Working though a book like Henry Sticker's *How to Calculate Quickly* is one way to develop this competency. [21]

Build a Strong Vocabulary—with both English and foreign language words

"Sense is generated by words that are combined into sentences of conversation to convey something about our ongoing experience" is how Weick opens his chapter on the substance of sensemaking. [22] In a nutshell, the larger and more diverse a vocabulary you have the more ways you can engage in sensemaking. Since native English speakers tend to think in English this is a natural place to increase the number of words in one's vocabulary. Intelligence analysts often focus on activity, intentions, and capabilities of countries overseas where foreign languages are spoken. In these cases, as the examples to be discussed illustrate, even a limited knowledge of the foreign language and words has contributed significantly to sensemaking.

Since words are the substance of sensemaking, they cut across all seven of the sensemaking properties. Words fall short of describing the perceptions of our experiences. They act as discrete labels. Although sensemaking never starts or ends (the ongoing property), words are used to chop up the flow of consciousness into the moments we describe. Heuer touches on the same point when he discusses the "Hardening of Categories." "If people do not have an appropriate category for something, they are unlikely to perceive it, store it in memory, or be able to retrieve it from memory later." [23] As an intelligence related example, he cites the inability to sense the Stalin-Tito rift because all Communist were

lumped into a single, homogeneous category called "international Communism" or "the Communist bloc." [24]

I found eight examples where R.V. Jones used a knowledge of words for sensemaking. All of these examples relate to the meaning of German words and their subsequent translation into English. Some also deal with making sense of the nature of projects based on their code names. Instances of English words playing a role in Jones's sensemaking are hard to find since these words are such an ingrained part of his thinking he made no special note of their contribution.

Two examples are explored here and a table listing additional examples is provided for reference. In the first example, Jones is trying to make sense out of German activity that later turns out to be related to the V-1 rocket program. This episode is noteworthy from a sensemaking perspective because it illustrates a phenomenon that crops up from time to time where the wrong path is followed, only to find the right answer. In mathematics, many proofs have been found to be in error, yet they yield theorems that turn out to be valid. Weick relates an incident where a small detachment of Hungarian troops found their way out of a snowstorm in the Alps by following a map of the Pyrenees! Even though the soldiers were using the wrong map, they were able to stay focused, orient themselves, and eventually reach safety. [25] This is not meant to advocate introducing errors or following inappropriate maps, but to point out that people are often able to make sense in spite of these handicaps. Here is how Jones describes the incident:

> I did not know quite how to interpret it [a German intercept], but its full significance struck me when Portal himself telephoned me personally and asked me what I made of it. Something he said made me realize that it was referring to the pilotless aircraft … Convinced now that we had unshakeable evidence about the pilotless aircraft, my first step was to see Cherwell because this would clearly 'let him off the hook' for any

blunders he might have made about the rocket. His prediction that there would be a pilotless aircraft was completely fulfilled.

Much of my interpretation was based on the fact that 'Flak Zielgerät' would mean an anti-aircraft target apparatus, and we had in fact evolved our own 'Queen Bee' remote controlled aeroplane for use as an anti-aircraft target in the years before the war. To my astonishment Cherwell, instead of being grateful, at once disagreed with my interpretation, saying that he was well experienced in the use of German (which was undeniable) and that what was meant was an 'anti-aircraft *aiming* apparatus', in other words a predictor.

... [later] Portal congratulated me on the amount that I had been able to deduce from the message: when I told him that he himself had done it, he was surprised—it turned out that I had misunderstood him on the telephone and that he had not seen the interpretation of Flak Zielgerät as a pilotless aircraft.[26]

The next example involves using a knowledge of culture and physics to make sense of two code named German projects. The first describes the Wotan, an electronic bombing guidance radio beam device, and the second describes the Freya radar. The clues pieced together based on these code words are not definitive in themselves, but combined with other sources they certainly helped Jones make sense of these enemy systems. The Wotan example:

Within a few days of the final proof of the existence of Knickebein, there was on 27th June another mention of it in an Enigma message. This simply said 'IT IS PROPOSED TO SET UP KNICKEBEIN AND WOTAN INSTALLATIONS NEAR CHERBOURG AND BREST.' So what was Wotan? And why was it mentioned along with Knickebein? Was it complementary or alternative to Knickebein? Just as there might be a clue in the meaning of Knickebein as Crooked Leg, was there some clue in Wotan? I knew, of course, that he was the Zeus of the German Gods (and still honoured, incidentally, by Wednesday) but was there anything unusual about him? I telephoned Bimbo Norman, whose scholarship in German heroic poetry I was coming to realize ... I asked him about Wotan, he replied, 'Yes, he was Head of the German Gods... Wait a moment... He had only one eye.' And then, shouting triumphantly into the telephone, 'ONE EYE—ONE BEAM! Can you think of a system that would use only one beam? I replied that I could, for in principle one could have the bomber fly along a beam pointing over the target, and have something like a radar station alongside the beam transmitter so that the distance of the bomber could be continuously measured from the starting

> point of the beam. A controller there could know both the distance of the bomber from its target and its speed, from which he could work out the correct instant at which the aircraft should release its bombs to hit the target.[27]

The Freya example:

> A few days later we encountered another Nordic deity, when on 5th July we learnt that German fighters had been able to intercept some of our aircraft owing to the excellent 'Freya-Meldung' ('Freya Reporting); and on 14th July we learnt that there was something called a 'Freya Gerät' ('Freya Apparatus'). So Freya appeared to be associated with air defence and involve specific pieces of equipment. I knew that Freya was the Nordic Venus: and since Wotan's one eye had seemed to give us a clue to a new bombing system, so I wondered whether there might be something about Freya that would provide a clue in air defense. I went to Foyle's bookshop and bought a book on Norse mythology, and I described the result which I wrote on 17th July under the title 'The Edda Revived':
>
> Actually the Decknammen Department of the Luftwafffe could hardly have chosen a more fruitful goddess, but few of her attributes have any possible relation with the present problem. She did, however, have as her most prized possession a necklace, Brisinga-men, to obtain which she not merely sacrificed, but massacred, her honour. The necklace is important because it was guarded by Heimdall, the watchman of the gods, who could see a hundred miles by day and night. There is a possible association of ideas with a coastal chain and a detecting system with a range of a hundred miles. Moreover, in Germany, the Brocken is pointed out as the special abode of Freya, and the mystery of the tower on the Brocken is well known. It is unwise to lay too much stress on this evidence, but these are the only facts concerning Freya which seem to have any relation to our previous knowledge. Actually Heimdall himself would have been the best choice for a code name for R.D.F [Radar], but perhaps he would have been too obvious.[28]

The following table lists eight word knowledge related sensemaking examples from Jones's book.

Example of Jones using Knowledge of Words in Sensemaking	***The Wizard War* Page Number**
Search for Hitler's secret weapon	65
Flak Zielgerät anti-aircraft target vice aiming device (V-1 Rocket Clue)	356-357
Stofflager fuel storage for V-1 propulsion	371
Wachtel regimental totem	374
Fortress of Kopenich	382
Knickebein: Crooked Leg & Wotan: Zeus code names	120
Freya: Nordic Venus necklace air defense system	121
Flak GAS and North Africa GAS poison gas false alarms	121-126

Practicing intelligence analysts provided a couple of examples where a knowledge of words contributed to their sensemaking. One analyst described an episode where a translated code name had been useful in sorting out the nature of a project. In another case, an ambiguity in the translation of the definite article "the" versus the indefinite article "a" was critical in making sense out of a problem he was working on.

One practical way of increasing your vocabulary is to read widely while keeping a dictionary close at hand. When you run across an unfamiliar word, look it up, write it down, and commit it to memory. Also, since even a rudimentary knowledge of a foreign language may pay off, try to become familiar with languages though self-study if professional foreign language instruction is unavailable. I have found a useful approach is to start by learning the basics using introductory books and tapes. Then I usually dive into foreign language versions of Juvenile literature classics like *Treasure Island* and *20,000 Leagues Under the Sea*. These books are often easier to read than other material and I am already familiar with the story lines.

Cultivate the Knack of Reasoning through Analogy and Stories

Klein points out that people use stories to organize "ideas, concepts, objects, and relationships."[29] They are a fundamental way to make sense. They are useful for sensemaking to grasp meaning for oneself and to convey meaning to others. Reasoning through analogy allows people to make sense of situations by relating elements of the new problem to those of a similar known problem.

> If we can find an analogy with which we feel comfortable, we can use it because it reflects the full set of causal factors, even the ones we cannot yet identify. The analogy also reflects the interactions between causal factors, interactions we cannot specify, so it lets us make a prediction that reflects factors whose existence we do not know and whose properties we do not know. That is the power of analogical reasoning.[30]

Another use of analogy in sensemaking is to make hard to grasp thoughts understandable in terms of human experience. This can be particularly useful in economic or science & technology intelligence where the scale of the numbers involved is either very large or very small. According to Von Baeyer:

> Only a narrow range of numerical values can be grasped intuitively—those falling between, say, ten thousand (a number you can actually count to in three hours) and one one-thousandth (the thickness of a human hair when measured in inches). Since most of physics deals with numbers outside this range, the writer must translate them into intelligible word pictures.[31]

Von Baeyer goes on to cite several examples of good analogies used to convey scientific and mathematical ideas. One example, "Caesar's Last Breath," is used to illustrate Avogadro's number (6.02×10^{23}):

> The theorem holds that with every breath you take, you inhale a single molecule of the air that Julius Caesar exhaled as he died … the point is that, although the earth's atmosphere is vast, the number of molecules in a human breath is also vast. If you were to measure the volume of the atmosphere with a bottle having the same capacity as your lungs, the total

> number of bottlesful would equal the number of molecules in one breath. And both quantities amount to about one tenth of Avogadro's number.[32]

Another example is "the royal chessboard" where the doubling of the number of grains placed in sequential squares is used to illustrate how fast geometric progressions become astronomical.[33]

Creating good analogies is as much an art as a science. Von Baeyer suggests the following rules for creating analogies:

> First, state the problem. It should be important, of universal concern, and genuinely incomprehensible, for good analogies should not traffic in the frivolous or the obvious. Next, introduce a familiar object or everyday activity that is instantly recognizable; describing one mystery in terms of another is a waste of time. If, in the third step, you can lead a reader to see the relationship between the incomprehensible concept and its simple analog, you have succeeded. But good analogies go one step further. By logical extension, they lead to something beyond what they were supposed to explain, to a prediction or an unexpected discovery, to something so surprising that it fixes the story in the reader's mind. When that happens, a precious instance of real learning has occurred.[34]

The use of analogy and stories are examples of both retrospective and social properties of sensemaking. They are retrospective in the sense that stories and elements used to construct analogies are always a part of someone's previous experience. They are social in that they provide a mechanism for sharing meaning and exchanging ideas and common experiences.

It should be noted that an inappropriate use of analogy can lead to trouble. Using the wrong analogy can lead to sensemaking that is misleading. For example, a flawed analogy is often what is behind "Fighting the Last War" syndrome where assumptions about the conduct of the last war are projected onto the next. Sometimes with disastrous results.

I found three examples where R.V. Jones used analogy for sensemaking. The first involves his use of a "smoke screen" to describe the radar countermeasure technique of

dropping strips of metal foil, called 'Chaff' by Americans and 'Window' by Brits, to create spurious reflections on enemy radar screens.[35] The second example involves his use of the Peloponnesian War as an analog for the conflict between Britain and Germany in 1939 and an admonition about the dangers of easy access to vital information by the adversary in the open societies of both Jones's London and Pericle's Athens.[36]

The next example relates how Jones came to understand the fallacy that radio waves with a wavelength shorter than 10 centimeters could not be generated using electronic vacuum tubes because the transit time for electrons to pass through the tube was too great. Jones came to see the error in this thinking after witnessing a demonstration of an aircraft mounted loudspeaker system developed for policing the North-West Frontier:

> When the apparatus had been perfected, it was demonstrated to the Air Staff at Farnborough by mounting a microphone on one side of the aerodrome, some two thousand feet away. If you spoke into the microphone you could hear your voice coming two seconds later across from the other side. All went well with the demonstration until one of the inspecting officers struck by the curiosity of hearing his delayed voice, started to laugh. Two seconds later there came back a laugh from the loudspeaker at which everybody laughed. Two seconds later the shower of laughter returned, and I like to think that by now the volume was so great that the returned laugh was picked up by the microphone and duly relayed once again, making a system that laughed by itself.
>
> Apart from the comedy of the situation, there was an important lesson to be learnt. This was that the time of oscillations generated by the human voice is typically of the order of one thousandth of a second, and yet these were being faithfully generated by a system in which the transit time of sound across the aerodrome was some two seconds. This showed the fallacy in the argument about the centimetric waves. What really mattered was not the transit time itself, but the regularity in the time of transit. So if electrons could be persuaded to travel at uniform speeds across the valve [vacuum tube] they could be made to generate oscillations of considerably shorter period and wavelength than the limit which the previous careless theory had predicted.[37]

Since reasoning (and sensemaking) using analogy and stories is an art, the best ways to gain competency are by practicing and studying examples.

Apply Persuasion Skills to Interact more Productively with People

Applying persuasion skills can be considered a form of indirect sensemaking. Where the previous approaches to enhance sensemaking have been primarily focused at the individual level, persuasion is aimed at improving sensemaking at the group and organizational level.

Persuasion can enhance sensemaking for intelligence analysis in two ways. First, it can help analysts steer collection activities toward better information. Second, it can help analysts persuade team members, when needed, and persuade customers to act on critical intelligence information.

Cialdini identifies six basic principles of persuasion that psychologists have shown to be effective in generating compliance.[38] The idea is that these principles tend to trigger almost automatic behaviors in people.

The six principles of persuasion are: [39]

No.	Principle	How it works	How to use it
1.	Liking	People like those who like them.	Uncover real similarities and offer genuine praise.
2.	Reciprocity	People repay in kind.	Give what you want to receive.
3.	Social Proof	People follow the lead of similar others.	Use peer power whenever it is available.
4.	Consistency	People align with their clear commitments.	Make their commitments active, public, and voluntary.
5.	Authority	People defer to experts.	Expose your expertise; don't assume it's self-evident.
6.	Scarcity	People want more of what they can have less of.	Highlight unique benefits and exclusive information.

The use of persuasion in sensemaking is enactive of sensible environments. Influencing other people allows you to move your agenda forward through their efforts. It can also make your actions more influential and, therefore, potentially more effective.

I found six examples where R.V. Jones used persuasion and influence to foster sensemaking. He used persuasion to garner scarce collection assets like aircraft flights to get additional information he needed. He used persuasion to get officers to act on the intelligence he was providing as in the case with Fighter Command during the Battle of Britain.[40]

One example has Jones using the authority of Sir Winston Churchill to keep a surveillance flight from being cancelled. Here is how Jones describes the incident (emphasis added):

> At that point the principal Deputy Director of Signals, Group Captain O. G. W. G. Lywood said something like, 'Well we now have the greatest expert on radio propagation in the country and he says that the beam theory is all wrong. We have wasted a lot of effort and let's not waste any more. This evening's flight should be cancelled!' I weighed up my position, and pointed out that Eckersley's evidence had neutralized itself, because he had said one thing a few months before and now something quite different. In that case I propose that his statements should be ignored, and that I already had so much other evidence that I was convinced that the beams existed. I told Lywood that *if he cancelled the flight,* which I myself had heard the Prime Minister authorize that very morning, *I would see that the Prime Minister came to know who it was who had countermanded his orders.*[41]

Most of the examples involved Jones finding ways to establish friendships as he did by exploiting a mutual interest in toy trains and fly fishing to get Air Vice Marshal R. H. M. Saundby to release two Mosquito aircraft for a mission needed to characterize German nightfighter defenses:

> … the one gap in our knowledge was the exact characteristics of the German nightfighter radar. We were almost certain that it operated on a wavelength of about 61 centimeters, but we needed to fly in front of a German nightfighter in order to obtain final confirmation. Such a flight would be very dangerous if carried out in an ordinary bomber, and we therefore needed one or two Mosquitoes which would be fast enough to make their escape once they had detected the transmission from any German nightfighter that was about to intercept them.

> Bomber Command had almost the entire production of Mosquitoes at that stage and our only hope of getting Mosquitoes quickly was to persuade the Commander-in-Chief sufficiently to let us have them.[42]

The following table lists six persuasion examples from Jones's book.

Example of Jones using Persuasion in Sensemaking	*The Wizard War* Page Number
Use of authority to keep Beam search flight from being cancelled	103
Use of reciprocity with Fighter Command to urge acting on intelligence	159
Use of liking with Air Vice Marshal Medhurst Air Staff(Intel)	183
Use of liking with Peter Stewart, Asst Director Intelligence(Photos)	194
Use of liking with H. T. Tizzard, Committee for the Scientific Survey of Air Defense	207-208
Use of Liking with Air Vice Marshal R. H. M. Saundby	283-284

Some people are born with persuasive charisma and charm. For the rest of us, it does not come so naturally. However, the principles of persuasion can be learned. The first step is to learn about the principles and how they work. Then look for opportunities to put them to use. Much about these principles is based on common sense and everyone has experienced them in one form or the other. Awareness and practice are the keys to developing this competency.

Conclusion

Four approaches to enhance sensemaking for intelligence analysis have been outlined in this report. Many analysts already use these approaches. The historical examples and discussions with practicing intelligence analysts attest to this. The potential for enhanced sensemaking to improve the quality of intelligence analysis is unknown.

Therefore, logical candidates for future work include research to quantify the contribution these approaches make to an analyst's ability to "make sense" and research to better understand the learning process required for analysts to master these skills. These are

difficult problems. Objective measures are hard to come by. Analysts must be studied in their natural settings.

Although the challenges for conducting sensemaking research are great, the pay-offs may be as well. For example, results may provide insights into how to efficiently capture expertise from senior analysts and pass it on to junior analysts. Also, a better understanding of the organizational properties of sensemaking in intelligence analysis may lead to better coordination within the intelligence community and fewer "surprises" slipping through the seams between agencies.

[1] Dennis K. Leedom, *Sensemaking Symposium Final Report*, Command and Control Research Program Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence, Washington, D.C., October, 2001. Available at: http://www.dodccrp.org/

[2] Karl E. Weick, *Sensemaking in Organizations* (Thousand Oaks, CA: Sage Publications, Inc., 1995), pp. 17-62.

[3] Richards J. Heuer, Jr., *Psychology of Intelligence Analysis*, Center for the Study of Intelligence Analysis, Central Intelligence Agency, Langley, VA, 1999. Available at: http://www.cia.gov/csi/books/19104/index.html

[4] *Ibid.*, Chapter 1, p. 3.

[5] *Ibid.*, Chapter 2, pp. 2-4.

[6] Weick, *Sensemaking in Organizations*, p. 31.

[7] *Ibid.*, p. 49.

[8] *Ibid.*, p. 39.

[9] Heuer, *Psychology of Intelligence Analysis*, Chapter 1, p. 4.

[10] *Ibid.*, Chapter 4, p. 2.

[11] Weick, *Sensemaking in Organizations*, p. 55.

[12] Reginald V. Jones, *The Wizard War: British Scientific Intelligence 1939-1945* (New York, NY: Coward, McCann & Geoghegan, Inc., 1978).

[13] Laura G. Militello and Robert J. B. Hutton, "Applied cognitive task analysis (ACTA): a practitioner's toolkit for understanding cognitive task demands," *Ergonomics*, Vol. 41, No. 11, 1998, pp. 1618-1641.

[14] Hans Christian Von Baeyer, *The Fermi Solution: Essays on Science*, (New York, NY: Random House, Inc., 1993), pp. 3-12.

[15] *Ibid.*, pp. 3-4.

[16] *Ibid.*, p. 7.

[17] *Ibid.*, pp. 5-8.

[18] *Ibid.*, p. 10.

[19] Jones, *The Wizard War*, pp. 192-193.

[20] *Ibid.*, pp. 453-454.

[21] Henry Sticker, *How to Calculate Quickly: The Art of Calculation*, (New York, NY: Dover Publications, Inc., 1955).

[22] Weick, *Sensemaking in Organizations*, p. 106.

[23] Heuer, *Psychology of Intelligence Analysis*, Chapter 3, p. 7.

[24] *Ibid.*, Chapter 3, p. 8.

[25] Weick, *Sensemaking in Organizations*, pp. 54-55.

[26] Jones, *The Wizard War*, pp. 356-357.

[27] *Ibid.*, pp. 120-121.

[28] *Ibid.*, pp. 121-122.

[29] Gary Klein, *Sources of Power: How People Make Decisions*, (Cambridge, MA: The MIT Press, 1998), pp. 177-196.

[30] *Ibid.*, p. 204.

[31] Von Baeyer, *The Fermi Solution*, p. 115.

[32] *Ibid.*, p. 116.

[33] *Ibid.*, pp. 118-119.

[34] *Ibid.*, p. 212.

[35] Jones, *The Wizard War*, p. 40.

[36] *Ibid.*, p. 72.

[37] *Ibid.*, p. 76.

[38] Robert B. Cialdini, "Harnessing the Science of Persuasion," *Harvard Business Review*, October, 2001, pp. 72-79.

[39] *Ibid.*, pp. 74-78.

[40] Jones, *The Wizard War*, p. 159.

[41] *Ibid.*, pp. 103.